

# A quantum Monte Carlo study of the one-dimensional ionic Hubbard model

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Quantum Monte Carlo methods are used to study a quantum phase transition in a 1D Hubbard model with a staggered ionic potential ( $\Delta$ ). Using recently formulated methods, the electronic polarization and localization are determined directly from the correlated ground state wavefunction and compared to results of previous work using exact diagonalization and Hartree-Fock. We find that the model undergoes a thermodynamic transition from a band insulator to a broken-symmetry bond ordered phase as the ratio of  $U/\Delta$  is increased. Since it is known that at  $\Delta = 0$  the usual Hubbard model is a Mott insulator (MI) with no long-range order, we have searched for a second transition to this state by (i) increasing  $U$  at fixed  $\Delta$  and (ii) taking the limit of  $\Delta \rightarrow 0$  at fixed  $U$ . We find no transition from the bond ordered state to a MI, and we propose that the MI state in  $1D$  is unstable to bond ordering under the addition of any finite ionic potential  $\Delta$ .